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May 7, 1857.

IN BURLINGTON HOUSE.

The LORD WROTTESELEY, President, in the Chair.

The following list of Candidates recommended by the Council for election into the Society was read, in accordance with the Statutes :—

Lionel Smith Beale, Esq.	John Marshall, Esq.
George Boole, Esq.	Andrew Smith, M.D.
George Bowdler Buckton, Esq.	Robert Angus Smith, Esq.
Thomas Davidson, Esq.	Charles Piazza Smyth, Esq.
George Grote, Esq.	Henry Clifton Sorby, Esq.
Rowland Hill, Esq.	John Welsh, Esq.
The Rev. Thomas Kirkman.	Joseph Whitworth, Esq.
William Marcet, M.D.	

The following communications were read :—

- I. "On the Plasticity of Ice, as manifested in Glaciers." By
JAMES THOMSON, A.M., C.E. Belfast. Communicated by
Professor W. THOMSON, F.R.S. Received April 1, 1857.

The object of this communication is to lay before the Royal Society a theory which I have to propose for explaining the plasticity of ice at the freezing point, which is shown by observations by Professor James Forbes, and which is the principle of his Theory of Glaciers.

This speculation occurred to me mainly in or about the year 1848. I was led to it from a previous theoretical deduction at which I had arrived, namely, that the freezing point of water, or the melting point of ice, must vary with the pressure to which the water or the

ice is subjected, the temperature of freezing or melting being lowered as the pressure is increased. My theory on that subject is to be found in a paper by me, entitled "Theoretical Considerations on the Effect of Pressure in Lowering the Freezing Point of Water," published in the Transactions of the Royal Society of Edinburgh, vol. xiv. part 5, 1849*. It is there inferred that the lowering of the freezing point, for one additional atmosphere of pressure, must be $\cdot0075^{\circ}$ centigrade; and that if the pressure above one atmosphere be denoted in atmospheres as units by n , the lowering of the freezing point, denoted in degrees centigrade by t , will be expressed by the formula

$$t = \cdot0075 n.$$

The phenomena which I there predicted, in anticipation of direct observations, were afterwards fully established by experiments made by my brother, Professor William Thomson, and described in a paper by him, published in the Proceedings of the Royal Society of Edinburgh (Feb. 1850) under the title, "The Effect of Pressure in lowering the Freezing Point of Water experimentally demonstrated†."

The principle of the lowering of the freezing point by pressure being laid down as a basis, I now proceed to offer my explanation, derived from it, of the plasticity of ice at the freezing point as follows:—

If to a mass of ice at 0° centigrade, which may be supposed at the outset to be slightly porous, and to contain small quantities of liquid water diffused through its substance, forces tending to change its form be applied, whatever portions of it may thereby be subjected to compression will instantly have their melting point lowered so as to be below their existing temperature of 0° cent. Melting of those portions will therefore set in throughout their substance, and this will be accompanied by a fall of temperature in them on account of the cold evolved in the liquefaction. The liquefied portions being subjected to squeezing of the compressed mass in which they originate, will spread themselves out through the pores of the general

* The paper here referred to is also to be found in the Cambridge and Dublin Mathematical Journal for November 1850 (vol. v. p. 248), where it was republished with some slight alterations made by myself.

† The paper by Prof. William Thomson, here referred to, is also to be found republished in the Philosophical Magazine for August 1850.

mass, by dispersion from the regions of greatest to those of least fluid pressure. Thus the fluid pressure is relieved in those portions in which the compression and liquefaction of the ice had set in, accompanied by the lowering of temperature. On the removal of this cause of liquidity—the fluid pressure, namely,—the cold which had been evolved in the compressed parts of the ice and water, freezes the water again in new positions, and thus a change of form, or plastic yielding of the mass of ice to the applied pressures, has occurred. The newly-formed ice is at first free from the stress of the applied forces, but the yielding of one part always leaves some other part exposed to the pressure, and that, in its turn, acts in like manner; and, on the whole, a continual succession goes on of pressures being applied to particular parts—liquefaction in those parts—dispersion of the water so produced, in such directions as will relieve its pressure,—and recongelation, by the cold previously evolved, of the water on its being relieved from this pressure. Thus the parts recongealed after having been melted must, in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied, and to enter again on a similar cycle of operations. The succession of these processes must continue as long as the external forces tending to change of form remain applied to the mass of porous ice permeated by minute quantities of water.

POSTSCRIPT received 22nd April, 1857.

It will be observed that in the course of the foregoing communication, I have supposed the ice under consideration to be porous, and to contain small quantities of liquid water diffused through its substance. Porosity and permeation by liquid water are generally understood, from the results of observations, and from numerous other reasons, to be normal conditions of glacier ice. It is not, however, necessary for the purposes of my explanation of the plasticity of ice at the freezing point, that the ice should be at the outset in this condition; for, even if we commence with the consideration of a mass of ice perfectly free from porosity, and free from particles of liquid water diffused through its substance, and if we suppose it to be kept in an atmosphere at or above 0° centigrade, then, as soon as pressure is applied to it, pores occupied by liquid water must in-

stantly be formed in the compressed parts in accordance with the fundamental principle of the explanation which I have propounded—the lowering, namely, of the freezing or melting point by pressure, and the fact that ice cannot exist at 0° cent. under a pressure exceeding that of the atmosphere. I would also wish to make it distinctly understood that no part of the ice, even if supposed at the outset to be solid or free from porosity, can resist being permeated by the water squeezed against it from such parts as may be directly subjected to the pressure, because the very fact of that water being forced against any portions of the ice supposed to be solid will instantly subject them to pressure, and so will cause melting to set in throughout their substance, thereby reducing them immediately to the porous condition.

Thus it is a matter of indifference as to whether we commence with the supposition of a mass of porous or of solid ice.

II. “On the part which the Silicates of the Alkalies may play in the Metamorphism of Rocks.” By T. STERRY HUNT, Esq., of the Geological Survey of Canada. Communicated by THOMAS GRAHAM, Esq., F.R.S., Master of the Mint. Received March 30, 1857.

In my last communication to the Royal Society on the Metamorphic Silurian Strata of Canada, I endeavoured to show, from the results of analyses of the altered and unaltered rocks, that it is the reaction between the siliceous matters and the carbonates of lime, magnesia, and iron of the sedimentary deposits, which has given rise to the serpentines, talcs, pyroxenites, chlorites, and garnet rocks of the formation. I then cited the observation of Bischof that silica, even in the form of pulverized quartz, slowly decomposes these carbonates at a temperature of 212° F., with evolution of carbonic acid; the same author mentions that a solution of carbonate of soda has the power of dissolving quartz under similar conditions*. Desiring to verify these observations, I have since made the following experiments.

* Bischof's Chem. and Phys. Geology, Eng. Edition, vol. i. p. 7.